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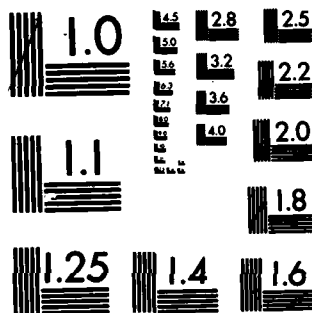
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ABSTRACT

The author spent six months in the Marshall Islands as a part of the Eniwetak Atoll clean-up project. The medical facility was a simple, semi-permanent structure in an isolated, tropical setting. Modern medical technology was both limited and remote. The major problems encountered were, in decreasing order of frequency: trauma, skin disorders, despression and alcohol misuse, infectious diseases, and heat stress. Basic preventative medicine, milieu therapy, and a simply stocked drug cabinet were the mainstay of our medical care.

The paper has three major purposes:

1. A descriptive study of the prevalence of medical problems encountered on the project.
2. An expanded discussion of medical and general public health problems in the South Pacific.
3. Considerations for future medical operations - military and otherwise in similar areas.

To make some of the clinic patient numbers more meaningful, I included patient counts from my private practice in Las Vegas (1974-76) for comparisons.

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PUBLIC HEALTH IN THE PACIFIC ISLANDS

by

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PUBLIC HEALTH IN THE PACIFIC ISLANDS

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Lloyd Earl Dodd, Jr., M.D.

THESIS

Presented to the Faculty of The University of Texas

Health Science Center at Houston

School of Public Health

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF PUBLIC HEALTH

**THE UNIVERSITY OF TEXAS HEALTH SCIENCE CENTER AT HOUSTON
SCHOOL OF PUBLIC HEALTH**

June, 1982

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INTRODUCTION

This paper is primarily a look at the types of clinic visits in a remote, South Pacific, peace time military operation - a kind of after-action report. I have tried to show what the primary problems were, how these differ from what many physicians are used to in our usual medical practice in the continental U.S. (CONUS), and why we encounter a different set of problems in this particular geographic setting.

To aid in showing how medical practice on the Pacific Island differs from a practice in CONUS, I used some comparison figures from my solo general medical practice in Las Vegas (1974-76). The Las Vegas figures are in no way intended to be a rigid "control" group but merely a rough comparison group. The Las Vegas numbers are probably fairly representative of comparable private practices about the United States.

To help understand the area we are talking about, we should remember that the "Pacific Islands" represent a heterogeneous group of islands/atolls which roughly share a common geographical region, similar climates, similar-though by no means identical- ethnic backgrounds, and a certain commonality of health-related problems.

The area we are discussing extends west and south from Hawaii (to include the slightly northerly Midway Islands) as far west as the Philippines, and as far south as New Caladonia and Tonga. The major islands and groups include

the Marianas, the Carolines, the Marshalls, the Gilbert, the Marquesas, the Phoenix, the Ellice Islands, the Tuamotu Archipelago, the New Hebrides, Fiji, Samoa and West Samoa, the Solomons, New Guinea and many smaller islands and groups in between.

One real problem I have had in the preparation of this paper is the paucity of literature available on general medical care in the area under discussion. The only over-all medical problems-article I could find was one I had written two years ago.¹⁰ That article dealt largely with a limited military population. Almost everything else I have been able to generate came piecemeal from a wide range of sources, some of whom were not even in accord on any given topic. What I have included in this paper is my estimate of the "best available" information at this time.

STUDY SETTING

The Eniwetak Atoll is part of the Marshall Islands located 2740 miles southwest of Hawaii. A coral atoll, it consists of 40 small islands in a rough circle, an average of 20 miles in diameter. The atoll was captured from the Japanese in 1944 and from 1948-58 was used as a nuclear testing area. Forty-three nuclear devices were detonated, including one fusion bomb.

The original Eniwetak inhabitants had been moved to nearby Ujeland in 1947, but in 1976 they were again given control of the Eniwetak Atoll. In preparation for the return of the Marshallese, the Department of Defense directed the logical debris left on the atoll. The Department of the Interior then directed planting crops and the building of homes and community buildings.

Among other things, the Air Force provided primary medical coverage with physicians, technicians, and supplies. The Army built the clinic buildings and contributed three to four field medics who worked at the job sites. The job sites were located on the various islands about the atoll. There were fixed medical facilities on the islands of Lojwa and Eniwetak.

Initially, most of the medical personnel assigned to the atoll were drawn from the Pacific Air Force (PACAF) area. I was pulled from Wheeler AFB, Hawaii.

On the atoll, the main administrative center for the project was located on the island of Eniwetak, the southern-most island of the chain. Roughly 400-500 people were located there. Work on a few of the southern islands

originated from Eniwetak. The Eniwetak clinic was staffed by a flight surgeon, four to five medical technicians, a laboratory technician, an environmental health technician, and a medical administrative technician.

The Eniwetak clinic facilities included four observation beds; an x-ray machine capable of views of the chest, extremities, abdomen, and an occasionally lucid view of the spine, and a laboratory with equipment for urinalysis, CBC, cultures, and some serology.

Lojwa was the base camp from which most of the physical work on the atoll originated. Located about the 2 o'clock position on the island chain, Lojwa was home for 400-500 military troops. Six mornings a week, most of the troops got up early, boarded the boats for their different work sites, and returned approximately 10 hours later. See Figure 1.

Lojwa's medical support consisted of an aid station staffed by a general medical officer and two medical technicians. Its laboratory was capable of only a CBC and urinalysis. There was no x-ray, and there were no observation beds. A dental team visited the atoll for two weeks each quarter.

A patient requiring immediate surgery might be sent to Kwajalein, 300 miles to the south. Otherwise, medical evacuation was to Tripler Army Medical Center, Hawaii. Such medical evacuation might take up to 60 hours from identification of need to arrival of patient. Medical evacuation from Lojwa to Enitewak was via Army "Huey" helicopters.

On Lojwa, our clinic routine was to hold an open sick call in the mornings before the boats left the island, another sick call in the evenings when the boat came back in, and an "open door" policy for emergencies - day or night. On Sunday, we held only one morning sick call.

All newcomers to the atoll ("newbies") were given a thorough briefing which covered the major health hazards and in which people were urged to seek immediate attention for any health problem. This "immediate" part meant that the techs and I got up more at night, but we feel that the overall morbidity rate was probably kept down by this advice.

The population we served on Lojwa was entirely military. There were 10 officers and a like number of senior non-commissioned officers (NCOs), and the rest were junior enlisted. The average age of most of these troops was perhaps 19 to 20 years. The average rank probably E2 to E4. Everyone on Lojwa and all the military were male. A rare female Department of Defense scientist or observer would stop over briefly on Eniwetak island. The Army was not being discriminatory, but the nature of the mission was hot, hard, and physical and the facilities were fairly primitive. All major races were represented.

When I proposed this paper, I had wanted to discuss some medical treatment of the native Marshallese, but I find that my records are too incomplete to give an honest evaluation of what we did for the islanders when we visited them in their temporary homes on Japtan and Medron (See Figure 1).

The type of work that our military men engaged in was to get up at dawn, boat out to another island job site, pick up all the contaminated concrete, metal reinforcing bars (rebar) and miscellaneous debris. They boated back to Lojwa at dusk. Once the island was picked up, another team (from either Lojwa or Eniwetak) moved onto the site and skimmed six or more inches of earth from the entire island. The dirt and debris were shipped to another island, Runit, and mixed with water and a substance called atapulgite to form a slurry which was poured into a huge atomic bomb crater. At the end of the project a thick concrete cap

was poured over the entire crater and the entire island was posted as off-limits to all native Marshallese.

Lojwa and Eniwetak were not exactly island paradises, either. Lojwa was flat, treeless, brushless, arid, about 10 feet above sea level, and just under three-quarters of a mile in total circumference. The only shade was in the semi-permanent tin buildings that served both for quarters and recreation areas. A fan was a treasure beyond price.

The highlights of the week were when the mail plane came in on Tuesdays and Fridays. So not getting any mail could be very disheartening.

There was a movie each night it didn't rain and the small library was open most of the time. The Bx - commissary was a small, self-contained trailer that was a nice place to visit because it was the coolest place on the island.

I could go on describing life on Lojwa for pages, but I think the reader is probably getting a feel for this work and setting: hot, isolated, physically demanding, and tedious.

The population of Eniwetak island was slightly different from that on Lojwa in that Eniwetak was the administrative center for the project and thus contained a much higher proportion of older, more senior officers and enlisted. Because of the administrative and control nature of the jobs on Eniwetak, fewer people were sent to off-island job sites so the nature of the stresses and injuries probably differed somewhat.

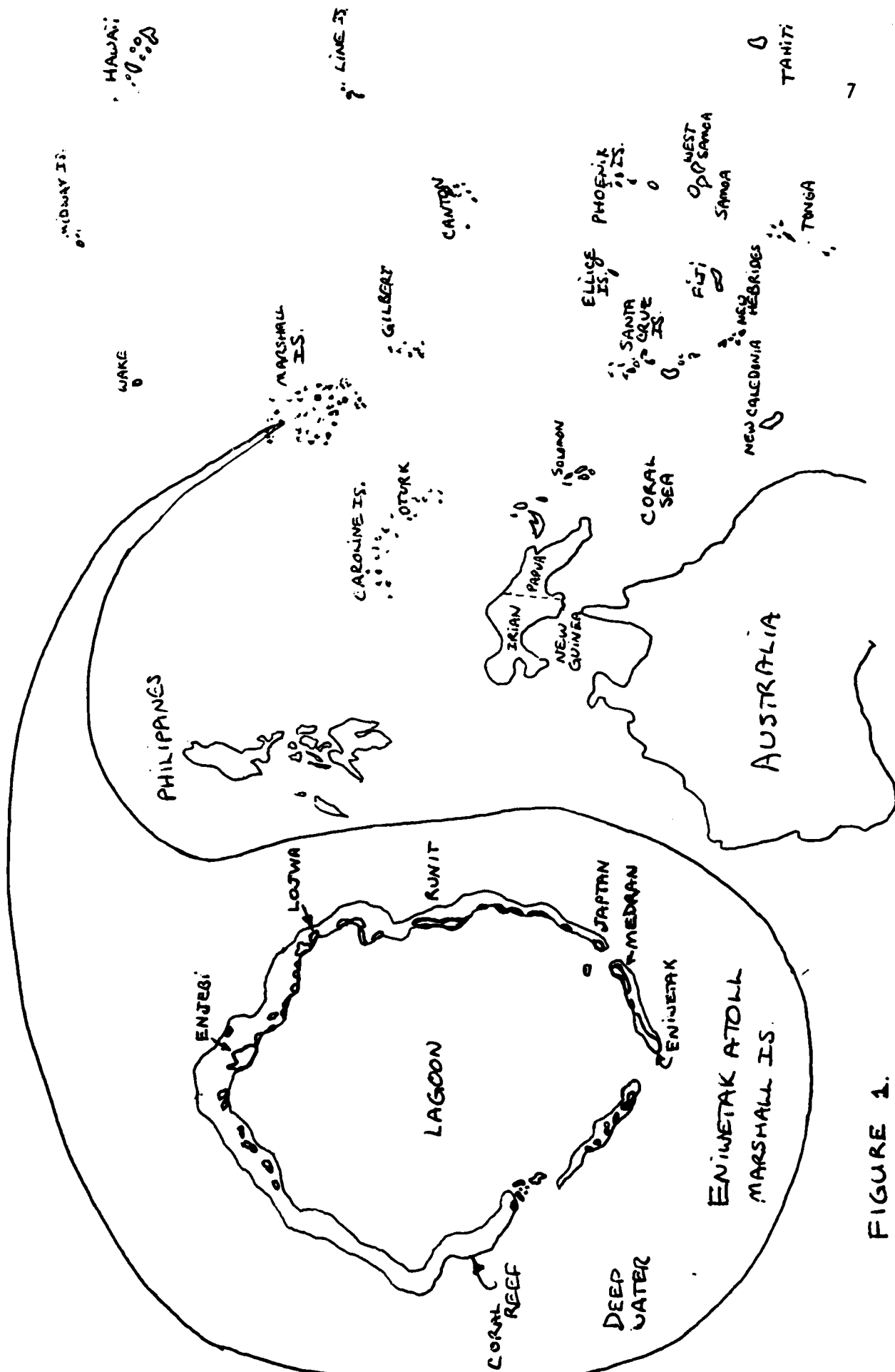


FIGURE 1.

STUDY RESULTS

I was stationed on Lojwa for six months, from May to October, 1978. Because I was curious about the patterns of illness seen in our clinic, I kept a log on the categories of patients seen for five of my six months there. I previously published an analysis of one month's clinic visits which broke down the visits into five problem groups.¹⁰ Table I included because it shows the typical daily patient load.

Table II shows the cumulative totals and percentages for the entire five month period (May through September, 1978). As can be readily seen, the month used for the initial study was surprisingly representative for the whole study period, the percentages remaining quite close for each problem group.

To make these numbers more relevant to the reader, I have compared them in Table II- to some rough data drawn from my private solo general practice in Las Vegas from 1974-6. Remember that the private practice group is an extremely heterogeneous group of all ages, all socioeconomic classes, both sexes and very diverse motivations and is not - nor meant to be- exactly comparable to the study group on Lojwa. My practice group, however, is probably roughly comparable to most similar general practices and open clinics in the U.S. I have not tried to generate a "control" group.

I have been unable to obtain comparable patient counts for a "typical" military practice. Looking at the study percentages next to the private practice percentages will illustrate the dramatic difference between practicing

Table I
Average Patient Visits by Day of Week
June 1978

| | Sun | Mon | Tues | Wed | Thurs | Fri | Sat |
|---------|------|-------|-------|-------|-------|-------|-------|
| Average | 10 | 39½ | 27½ | 27 | 32 | 31 | 21½ |
| Range | 9-13 | 34-43 | 21-34 | 19-33 | 29-40 | 22-42 | 23-29 |

Table II
Patient Problem Breakdown (May-Sept, 78)

| Problem Group | No. Patient Problems | Lojwa % Total | Las Vegas Percentages |
|---------------------------|----------------------|---------------|-----------------------|
| Trauma | 1125 | 37.43 | 15.18 |
| Dermatology | 1011 | 33.63 | 8.10 |
| Psychology-Alcohol Misuse | 449 | 14.94 | 12.18 |
| Infectious Disease | 282 | 9.38 | 36.32 |
| Heat | 139 | 4.62 | .08 |
| Chronic Diseases | - | - | 28.14 |

Total no. patient visits on Lojwa - 4298

Total no. separate patient problems - 3006

medicine in the usual setting here in the U.S., when most physicians are accustomed to, and practicing in an isolated military situation on a pacific island. Below is a discussion of each of the major problem areas seen on the atoll.

Trauma

Over 37 percent of all initial complaints are related to physical trauma in some manner. Remember, the typical patient we saw was probably a 19-year old Army E-2 to E-4 grade. These were mostly young, healthy, vigorous troops, which probably partially accounts for our relatively low re-visit rate for each problem. All the military people had been physically screened prior to coming to the atoll. Many potential medical and dental problems had been intercepted and treated at their home stations or in Hawaii.

The trauma cases were further broken down as to cause. About three percent were due to altercations. Twenty-five percent were due to sports injuries. That 70 percent of all trauma was job-related came as a bit of a surprise even to me - though perhaps I should have anticipated such figures.^{14,19} Further review showed that almost all of these injuries were quite minor; small lacerations, mild contusions, and pulled muscles and ligaments.

One of the most persistently vexing problems came in assessing "mechanical back pain" for true degree of severity vs. degree of "psychological overlay" for secondary gain.

The salient point to keep in mind about the job-related trauma is that it was essentially quite minor and quite expected in young men doing hard, physical labor all day. Serious injuries were, fortunately, very few, probably due to the attention given to safety by the Army NCOs.

During the five month study period there were 11 medical evacuations from Lojwa to Eniwetak - most for suspected fractures of a major extremity. Recall that Eniwetak had the x-ray machine. Four of these patients went on to Hawaii. One had a dislocated hip from falling off the back of a moving truck. One man had a septic knee which cultured Staph aureus. The original source of his infection was probably a neglected coral cut on his anterior leg. The third had a broken femur from a job-related accident. The fourth had a fever of unknown or undetermined origin (FUO).

We saw 49 minor cases of superficial foreign bodies in the cornea. ?

One very important fact I learned early was that, while malingerers could not be tolerated, even the truly injured man needed to be mobilized as soon as physically possible. Certainly, man hours toward mission accomplishment were important, but from the medical point of view, another reason was just as essential. A man not actively occupied might rapidly become bored and depressed. Thus it was necessary to see injured patients frequently so that when we believed he was ready, we sent him back to work. It might not always be the same heavy work he was doing, but even light duty or "gopher" work was generally better for a man than prolonged time not occupied. The same rationale held for the six-day work week. More work was turned out, of course, but an argument could be made that two consecutive days off each week might actually have promoted depression for some of the men.

Dermatology

Table III
Dermatology

| Diagnosis | No. of Cases |
|------------------------------------|--------------|
| Tinea (all sorts) <i>infection</i> | 402 |
| Heat rash | 143 |
| Otitis externa <i>infection</i> | 48 |
| Sunburn | 86** |
| Acne | 37 |
| Miscellaneous | <u>295*</u> |
| Total | 1011 |

* 5 cases were secondary degree sunburn of the buttocks

** Mostly superficial Staph infections of otherwise minor abrasions

In the heat and humidity of the South Pacific, tinea is ubiquitous and bacteria flourishes in the many cuts and scrapes suffered by these men.

An interesting side note is that none of the Staph cultured proved to be penicillin resistant, and apparently no strains developed resistance in the course of treatment. With the exception of a few abscesses, most infections responded very promptly to vigorous cleaning and either topical or parenteral antibiotics as was appropriate.

Unfortunately, I have no breakdown of the types of dermatosis seen in my Las Vegas practice, but I suspect that tinea would have been relatively less significant and probably "acure" and the "miscellaneous" categories proportionately larger in the Las Vegas setting due to the age range of the private practice

patients - including childhood impetigo, pubescent acne and the chronic dermatoses of maturity.

Infectious Disease

Table IV
Infectious Disease

| Diagnosis | No. of Cases |
|--|--------------|
| ^{Deam} URI - Viral most likely | 89 |
| Gastroenteritis* | 66 |
| Conjunctivitis | 61 |
| Otitis Media | 38 |
| Herpes Simplex | 25 |
| Cystitis | 2 |
| F.U.O.** | <u>1</u> |
| Total | 282 |

* Based on clinical presentation, excluding cases of probable ethanol abuse gastritis

** Included here because of general toxicity and systemic symptoms. The patient was later evacuated out and lost to follow-up.

As can be seen from Tables III and IV, infectious disease was not a major cause of clinic visits on Lojwa. A number of possible explanation came readily to mind. All personnel en route to the Eniwetak Atoll had physical screening at their home base and review in Hawaii, and many minor problems were undoubtedly treated there. Also, remember that the work done on the atoll was outdoors, away from the closed office/school type environment which seems to promote the person-to-person spread of disease. Finally, the Army med techs went to the job sites with the troops and probably treated cases without reporting them to us in

the clinic, though normally we supplied, supervised, and conducted in-service training for the Army medical technicians as well as our own Air Force medical technicians.

Heat

A very significant problem on the atoll was the combination of heat and humidity. The temperature officially logged on Eniwetak ranged up to 94°F with up to 80 percent humidity. Unofficial Lojwa temperatures have been reported over 124°F. Just being outside at times is physically stressful. Most of the work was out-of-doors, physically demanding itself, and at times involved working in anticontamination (anti-C) suits, which markedly reduced the benefits of the trade winds - those light breezes that made life bearable for the rest of us.

Work schedules were developed in which a man in an anti-C suit would work for part of an hour - say 15-30 minutes - and then be off for the rest of the hour. Men not in anti-C suits would work for a full hour and then break. The frequency and duration of the rest periods was ideally a function of the heat stress as measured at our aid station by the Wet Bulb Globe Temperature (WBGT) apparatus. The WBGT is a device to estimate the core temperature of the body. ?
See Table V.

Nevertheless, we treated several cases of heat exhaustion, and other incidents were probably handled by the Army medics on the various work sites and not always reported to us at the medical facility.

The rest of the heat-related problems, excluding heat rash, were generally related to milder degrees of dehydration. Presenting complaints might be headache, malaise, or dysuria, but the urine specific gravity in these latter cases was nearly 1.035 or more. All symptoms promptly resolved with adequate

Table V
Heat Categories and Recommended Courses of Action

| Heat Category | WBGT Index | Nonacclimated Personnel | Acclimated Personnel |
|---------------|---------------|--|---|
| I | 82-84.9° | Use discretion in planning intense physical activity. Limit intensity of work and exposure to sun. Provide constant supervision. | Normal Duties |
| II | 85-87.9° | Strenuous exercises will be cancelled. Outdoor classes in the sun will be cancelled. | Same as for non-acclimated personnel. Heat category I. |
| III | 88-89.9° | All physical training, strenuous activities, and parades will be cancelled. | Strenuous outdoor activities will be minimized for all personnel with less than 12 weeks in hot weather. Thoroughly acclimatized personnel can carry on limited activities for periods not exceeding 6 a day. |
| IV | 90° and above | Strenuous activity and non-essential duty will be cancelled, if operational requirements permit. | Same as for non-acclimated personnel, Heat category IV. |

There were times when the WBGT index was more than 100°!

hydration and rest.

The men were instructed to liberally salt their food at meals. Salt tablets were not used.

See "Eniwetak Atoll Instruction #5602 in appendix. This EAI was the basis for the in-depth initial indoctrination briefing and the monthly refresher talks given to personnel on the atoll.

Appropriate use of the WBGT equipment is outlined in AFOSH, STD. 161-12, an excellent publication on "The Etiology, Prevention, Diagnosis, and Treatment of Adverse Effects of Heat".¹

Psychological and Alcohol Abuse Problems

I left this area for last because it is generally the most complex and least given to precise statistical manipulation, yet it bears discussion here because it was a real part of life on the Atoll.

In this category, I included not only depression and depressive-anxiety syndromes, but also the cases of ethanol-related problems which I thought related to the Atoll environment. Thus, I did not include the cases of those individuals who turned out to have had severe alcohol abuse problems prior to coming to the Atoll.

Eniwetak is an isolated assignment. The men need recreation and diversion, but in spite of the organized recreational facilities, there is frequently a sense of being isolated, out of touch with family and familiar surroundings, and some times even the sense of being lost and forgotten. I am most certainly not saying that there were inadequate provisions for free-time recreation - quite the contrary. But after a certain point, men became bored with movies, the recreation center, and the club activities. The sports may not appeal, and, in a few chronic fatigue may become an aversive factor contributing to depression.

Many men become depressed and consequently begin drinking in excess. Of course, not everyone who drinks too much is depressed. Some drink just to make the days go by faster. Some drink a lot because of peer pressure. But the observed relationship between depression and excess ethanol use is frequent enough to warrant comment.

For our purposes, pathological depression is that which is so severe so as to seriously interfere with work, social life and cognition - usually with at least some suicide ideation. Alcohol abuse might be similarly defined, minus the suicide ideation.

In actuality, with rare exceptions, nearly everyone on Lojwa (and presumably on Eniwetak, though the island populations differed somewhat as previously discussed) had some degree of depression at some point in their tour. For most it amounted to no more than a couple of weeks of "the downs". Staying constructively active and avoiding prolonged personal isolation nearly always helped.

At any rate, we treated an average of six to eight cases of fairly severe depression, and many milder cases each month. Our treatment simply consisted of frequent interviews involving the patient's milieu, work, friends, squad leader, and the clinic staff. We encouraged mixing with other people and almost any free time activity that the patient viewed as constructive. We gave no anti-depressants.

Interestingly, the depression we observed on Lojwa followed a fairly consistent pattern. There were few complaints from people who were in their 4-6 weeks Atoll; but then after the novelty had worn off and the primary recreations had been experienced, the prospect of month after month of heat and work and tedium began to depress. So regular was this pattern that if clinical depression appeared at any other time we automatically had reason to look for another cause, i.e., a "Dear John" letter or some other problem at home. In one instance, late

in the summer, a man who presented with depression in his first week on the atoll puzzled us until we discovered a previously concealed history of hospitalizations for emotional reasons. The other men with similar presentations in the first couple of weeks proved to be malingering - that is, having no physical problem and deliberately trying to deceive their supervisors to get out of work or be sent home early.

Yet, it seemed to me that those most susceptible to true depression were those with fewest mental resources, those least able to entertain themselves, or those whose interests were narrow and not available on the island (i.e., the man whose sole pleasure was working on his car). As people became bored or depressed they began coming to the clinic complaining of headache, anxiety, sleeplessness, fatigue, aggression, mental confusion, or morbid thoughts - a fairly representative complex of depression symptoms. Treatment as was described above.

If alcohol became a problem, we had an Antabuse^R program that we administered at the clinic. We encouraged Antabuse^R use for a few patients.

Almost as predictably as it had appeared, the depression would perceptibly improve near the end of the third month and generally cease to be a problem by the middle of the fourth month. So we are concerned about a period of about four to six weeks, starting roughly six weeks into the five to six month tour.

We had no suicide attempts, and no one had to be removed from the Atoll for de-novo emotional problems. I was generally pleased with our success.

The relatively poor communication with home became a problem for those who had, or thought they had, family difficulties. Frequently, anxiety could be relieved simply by establishing good communication - often via the Red Cross. Where real problems existed, a man occasionally had to be taken off the atoll for

period of time to settle his affairs and then usually returned later to finish his tour.

Actually, part of the problem may have been the length of the tour. Air Force and Navy personnel stayed for 170-179 days while Army troops were relieved after approximately 150 days. The difference in tour lengths was not a problem. Rather, the complaint was spending five to six months on a rock. The troops often compared their tours to prison terms. Many of the enlisted felt they lost money on their paychecks each month since they could not draw separate rations pay.

No one received credit for a "remote tour" only temporary duty (TDY) which meant we were all still eligible immediately for another isolated assignment.

If there were one single recommendation I might make it would be that - whenever mission continuity would not be threatened - the tour be reduced to 90 days. I am convinced that this single change would dramatically reduce the problems of depression, anxiety, and hostility. Initial costs would be increased somewhat, but these would probably be largely offset by long-term improvements in morale and productivity.

PUBLIC HEALTH CONSIDERATIONS ON ENIWETAK

No discussion of the medical aspects of the Eniwetak tour would be complete without at least a brief review of several other environmental health factors. I have already discussed the weather.

Food was brought into the Atoll mostly by barge, but sometimes by air. The water was produced by distilleries on Eniwetak and Lojwa. Inspection of food and water was conducted regularly by the Air Force environmental health technician. The water was appropriately chlorinated.

Insects were a very minor problem and caused trouble only when an occasional bite became infected. There were no mosquitoes and very few bees. Ants were ubiquitous but rarely more than a minor irritation. Black widow spiders were found on Lojwa but no bites were reported.

The rat population had survived the atomic testing rather well and was extremely evident on all islands. However, early studies demonstrated that these rats were relatively disease-free in the sense that they served to vector no diseases to man. There were no ticks and only a very rare flea. There were no rat bite incidents reported to us on Lojwa.

World War II ordnance can still be found on some of the islands and is still potentially dangerous. The possession and disposal of all ordnance was strictly controlled while we were there.

Noise was a problem around the heavy equipment, at the power plant, and on the boats that shuttled between the islands. I conducted occasional (spot-

check) inspections, and, in general ear plugs or muffs were used properly.

Radiation hazards were closely monitored by an Air Force Field Radiological Survey Team (FRST), and anti-contamination techniques were rigidly enforced. A complete blood count (CBC) was done on everyone prior to arrival on the atoll and again subsequent to departure. Urine specimens were collected on each individual prior to leaving the Atoll. Such specimens were used to assess alpha particle exposure.

Several cases of severe occupational conjunctivitis occurred when a new type of eye shield was used by men mixing the atapulgitite with contaminated dirt. The new eye shields were vented and allowed the atapulgitite to filter in, mix with sweat and irritate the conjunctiva. We corrected the problem by taping over the vents until a supply of different goggles could be obtained.

Solid waste was landfilled on a neighboring island and bulldozed over each evening. Liquid wastes were vented far off-island (with careful attention to currents).

Sharks and other dangerous sea life were abundantly evident on the Atoll.

Sunken WWII warships and heavy equipment discarded after the nuclear testing years formed what was functionally a grotto that favored both food - fish and shark. However, only one reported shark attack occurred and that was not fatal. A civilian was photographing a four foot shark in about 15 feet of water, and he unintentionally provoked the shark and suffered minor lacerations to both arms as a result. Some of the Navy divers, on the other hand, reported that they actually made pets of some of the sharks that followed them about and the sharks occasionally ate some of the plastic demolition charges before they could be detonated.

One Navy diver encountered what was thought to be either a stonefish or a lionfish and suffered tremendous pain and some transient local paralysis of his right lower extremity. His friends pulled him from the water and urinated copiously on the sting site. Recovery was complete within a few days in spite of the medically unorthodox treatment.

We saw a few cases of what appeared to be ciguatera poisoning as a result of the ingestion of the local fish. Ciguatera is a toxin generated by certain fungi which grow on coral atolls. Fish that subsist on the fungi have grown immune to its effects, but further up the food chain, this naturally occurring toxin concentrates in certain species of fish, and the toxin can be potentially lethal to man if the dose is huge enough. Military personnel were warned frequently not to eat the fish they caught because most people could not tell which were safe to ingest.

The only fatalities of the entire two-year project (2000 man-years) resulted from one man being crushed between two tractors and two men disappeared while sailing in the lagoon. One of the latter two was the sailing instructor and the other was the physician who replaced me at Lojwa.

PUBLIC HEALTH ELSEWHERE IN THE PACIFIC

In many respects we were very fortunate on the Eniwetak Atoll in that we had a very small, well-controlled environment and relatively few major public health problems. Certainly, there are many similar coral atolls, but most atolls have more diverse vegetation, larger indigenous populations, and more insects-rats-pests. Further, many Pacific islands are either volcanic or part of a more stable continental land mass, and as the size of the island and the density of population increases, so does the range of disease and hazards that the islanders are subject to.

Leprosy is found in all forms in the South Pacific as is Leptospirosis and Lymphopathia Venerium.²⁰

Rabies, on the other hand, is not a problem at all and neither is Schistosomiasis (except for a few isolated *S. japonicum* cases on some northern Philippine islands). *neglected tropical diseases*

Toxoplasma gondii is endemic to most of the southern and southwestern islands.

Intestinal and extra-intestinal parasites are common in some areas of the South Pacific.¹⁶ Bancroftian filariasis is found on many islands - including Samoa and Fiji - and may or may not show the typical night periodicity of microfilariae in the bloodstream. The probability of ultimate elephantiasis is high.

Ascaris (round worm), *Enterobius vermicularis* (pinworm), *Strongyloides stercoralis*, *A. caninum* (hookworm), *Toxocara canis* and *T. cati*, and *Trichuris*

trichiura are all common. Even Anisakiasis (herring worm disease) has been reported. *Taenia saginata* and *T. solium* (tapeworm) are relatively common. *Gnathostoma spinigerum* occurs from eating raw fish with the encysted third stage larvae.

Eosinophilic meningo-encephalitis occurs sporadically and in small epidemics in the Pacific islands when there is invasion of the CNS by developing adult nematodes of several species, the commonest being *Angiostrongylus cantonensis* (rat lung worm) after the ingestion of raw prawns, crabs, slugs, and land snails.^{20,31}

Kelly has even reported some unusual *Strongyloides fulleborni*-like infections in man in Papua New Guinea.¹⁷

Trematodes as well as nematodes are a problem, especially on the larger islands with ample fresh water and fresh water sealife. Hepatic, intestinal, and lung fluke infections are common - particularly on the southern and southwestern most islands.²⁰

Malaria is still (and probably ever will be) prevalent in the Pacific islands.^{7,25} The disease was so common in WW II that whole companies had to be withdrawn from action when their malaria attack rate became too high. My father reported, however, that when a man or a unit was withdrawn was frequently dependent upon the military situation as well as the medical one. When the fighting was fierce and support was scant, a man might stay on the line fighting until his temperature reached 104° or he became delirious - whichever came first.¹¹

Many authors recommend prophylaxis when going into or through high risk areas. The most common/most effective prophylaxis is probably the chloroquine (300 mg) - primaquine (45 mg) tablet given weekly.⁵

Tropical ulcers associated with *Bacillus fusiformis* and *Treponema vincenti* are common but easy to treat once the diagnosis is made. Without prompt diagnosis, however, these ulcers may take years to resolve and leave scarred or atrophic skin.

Flea-borne (murine) and mite-borne typhus occur wherever the rat lives in close association with man.

Typhoid and paratyphoid fevers are also worldwide in their distribution. The bacilli have been recovered from sea water and concentrate greatly in the shellfish that many islanders love to eat raw.⁵

As might be imagined, diarrheal and dysentery diseases are common in the Pacific islands,^{15,24,26} again mostly in the southwestern islands but found to a considerable extent everywhere. Viral syndromes predominate, but *Shigella* is common and produces a generally mild, self-limiting disease with a low mortality (except in infants).²⁹

Vibrio cholerae, comma vibrio, including the classical and El Tor biotypes, and the Inaba and Ogawa serotypes have all been found, though disease caused by these variants is clinically indistinguishable and treated the same.

Yellow fever is not now a problem in the southern Pacific islands though all the ingredients for outbreaks are present.⁶

Dengue, however, and Dengue Hemorrhagic fever were reported in several island groups in the 1970's, including Fiji, French Polynesia, Nive, Nauru, and Tonga.²⁰

Pitvipers and elapids which are so much a hazard in Asia and South America are not all common in the Pacific islands, but the south Pacific coastal waters abound with sea snakes.

Seasnake bites are very common among fisherfolk and envenomation occurs in about half of all bites. Current statistics indicate that about half of all envenomed bites are fatal but many authors question this number. There is evidence that many victims of seasnake attacks do not go to hospitals but to local healers who employ a variety of "treatments". When local remedies fail the patient is then taken to the hospital. Since our frightening numbers are based on the survival of hospitalized patients, we may be over-estimating the lethality of the seasnake,^{16,20}

Other toxic sealife include stingrays and the large group of coral-loving scorpionfish (Scorpaenidae) with two major subgroups: Pterosis species (zebrafish, lionfish, and tigerfish) and Synauceja species (stonefish, primarily). The scorpionfish are capable of inflicting an incredibly painful sting which is often accompanied by temporary paralysis/parenthesis of the area attacked.

Chirposidae (man-o-war) is common but rarely causes death. Closer to Australia, however, the box jellyfish (chironex fleckeri) frequently kills the massively stung human.

There are no important (insect) scorpion species in the area under discussion though black widow and brown recluse spiders are found everywhere.

If the medical officer is charged with treating the native islanders, he will find himself in a whole new world.

The diet is different. Malnutrition (not necessarily starvation) may be found with vitamin²² and iron deficiency^{9,14} on a huge scale.^{3,13,30}

Concepts of self-care and personal hygiene are different.^{4,12}

The environment and the interaction of the islander with his environment may be difficult for the U.S. raised physician to understand.²⁸ Some diseases

such as smoke-induced bronchitis due to the cooking-heating habits of the islanders may be outside the physician's experience.^{21,27}

Unfortunately, many of our social problems and diseases have found their way to the islands and both smoking and venereal disease are all too common everywhere.²³

What may not be common, however, is the attitude of the islanders toward the physician, western social values, and toward medicine in general.⁸ Attitudes held by people in "developing" countries may be grossly different from what the physician is used to and profoundly effect the islander's response to disease or injury.³² The physician must either learn to work within the islander's framework, must entirely re-educate his patients, or must resign himself to being ineffective.^{8,12}

Basch's International Health not only gives a good review of some of these attitude differences but also lists many good references.⁴

Air Force Regulation 161-13 details the immunizations given to an Air Force military personnel. All Air Force people get regular shots for tetanus, influenza, polio (drops), diphtheria, and small pox (because of the possibility that smallpox could be used against us as a biological weapon of war). All military personnel leaving CONUS receive a tuberculosis (TB) skin test and the typhoid series. As many of the Pacific islands fall into WHO's "area II", cholera vaccine is also given, though some authorities question its effectiveness.

RECOMMENDATIONS FOR ESTABLISHING A REMOTE MEDICAL FACILITY

The following comments are based on my experience on Lojwa, my training as an Air Force Disaster Preparedness Officer, participation in Air Force training such as Operation Medical Red Flag II, commanding the Vandenberg AFB Medical Mobility Team as well as a review of what literature is available.

Several factors must be considered when deciding what type of medical facility to erect at a given site:

- 1) The number of people to be cared for - military and civilian.
- 2) The expected duration of the project.
- 3) The locale lending itself to- or prohibiting- some types of structures due to terrain, climate, or whatever.
- 4) The nature of the job. Disaster relief tends to be short term, high volume; radiation clean-up tends to be long term, low volume.
- 5) Whether the site will be subject to hostile action.

Whenever possible, consider first the use of "instantly" available "medical" facilities to handle the problem or to act as stop-gap while more permanent structures are built. The Air Force, for example, has many six-man (1 doctor) Air Transportable Clinics (ATC's) and somewhat fewer 42-man (5-6 doctor) Air Transportable Hospitals (ATH). These facilities are kept in storage but periodically taken out, set up and exercised. Medical staffs are pre-assigned and kept on mobility status. These facilities can be dispatched within hours to any part of the world and be fully operational within hours of arrival.

The Army has even larger mobile hospitals that can in some cases be expanded into full field hospitals with up to 250 beds!

The ATC and ATH are both "soft" tent facilities, but the larger Army units can be hardened and can provide the basis for long-term as well as larger operations.

The ATC and ATH would then be naturals for -say- flood or earthquake relief under most circumstances. The units could also be used as interim measures when a base had to be rapidly set up or moved.

The larger Army facilities could offer better climate protection and protection from hostilities as well as potentially provide care for larger numbers of people. The Army units can act as regional hospitals where the above-mentioned Air Force units are more short-term "patch and transport" type units.

These smaller units, however, would probably be preferable for most operations on the smaller islands and atolls in the Pacific.

If the operation is one in which emergency measures are not called for, where the length of the prospect may be a year or more, then wood-frame, galvanized tin structures might be more appropriate. Radiation clean-up projects are still being considered for perhaps two other Pacific atolls. Obviously, each situation has to be individualized.

The medical planning and execution for the Eniwetak Atoll Clean-up Project at almost all phases and the logistics people deserve kudos. The only comments I could make would be minor.

Whenever possible, for reasons discussed earlier, tour length should be limited to 90 days rather than six months. Morale and productivity would unquestionably improve with the shorter tours.

In those cases where dental care is only sporadically available, the general medical officer or flight surgeon assigned to the operation should get a brief (1-2 day) cram course to refresh his handling of common dental problems such as temporary filling, damaged teeth, and oral infections.

Similarly, where the flight surgeon might be expected to have some familiarity with tropical diseases and problems, the general medical officer should not be assumed to have such expertise, and for his sake - as well as for his patients - he should receive some background briefings and readings prior to departure for the project, especially if he is to treat native islanders.

Perhaps one of the most interesting outcomes of this study is the fairly consistent appearance of depressive symptoms at some point in the tour, typically is the second to third month as previously indicated.

I cannot believe that this problem was unique to this particular military operation. The questions, instead, must be "is there any common pattern of depression/alcohol misuse?" and "what tools are most effective in combating these problems".

Are existing programs of sports, movies, USO shows, library availability and so forth, really adequate as now used or could they be modified to better serve the troops.

For that matter, civilians are at times also subject to remote, isolated stressful assignments and medicine in general would be advanced if we could answer the above questions.

But before we can rationally answer these questions we need to gather some meaningful data.

One possible approach to this subject would be to develop an appropriate questionnaire, administer it to troops at their initial screening prior to departure for their remote assignment, repeat the questions at two and eight weeks post arrival and prior to departure from the remote operations. This schedule would give not only baseline data but also perhaps show a change in attitudes or activity.

The next question would involve the questionnaire itself. It would have to include some basic demographic questions such as name (or code number), age, occupation before and in the military, rank, education, race, marital status and time in the military.

Other questions would focus on how a person spent his time - both at work and at leisure (sports, reading, other hobbies) and questions relating to alcohol and perhaps medication use.

Finally, the form would have to provide for some possible changes in both the demographic data (i.e., marital status) and the data relating to use of time and alcohol.

The concluding step in the study would be to correlate and interpretate the answers given on the questionnaire with the appearance (or lack thereof) of clinical depression or alcohol misuse as defined earlier. Particular attention would be given to the relationship between sports in general, sports in particular, non-athletic past-times, group vs. individual pursuits and the appearance of clinical depression on alcohol misuse. What recreational activities seemed to help the most? Least? Is there a personality pattern that is most susceptible to these problems?

Comments or suggestions from the study participants would be welcomed.

Perhaps such a study would shed some light on depression in general, thus contributing to the overall body of medical literature. More cogently, the study might give clues as to what further steps the military can take to make our remote operations more palatable to the troops involved and thereby perform a real service to the individuals as well as the military.

SUMMARY

In this paper we looked at a simple prevalence study of clinic visits in a peacetime military operation in a remote setting. To make the descriptive figures more meaningful, I included some figures from what I think is a "typical" private practice just to give the reader a basis for comparison.

The study showed that illness/injury patterns are probably very different from what most physicians are used to in our medical practices. Minor trauma and usually simple dermatological problems accounted for two-thirds of our workload. Primary depressive syndromes were prominent and at times severe. Depression and boredom probably figured significantly in many other patient visits, just as they might have in almost any general practice. Finally, the environmental factors of high heat and humidity caused some problems unique to this particular tropical setting.

Common sense and a relatively simple stock in the pharmacy cabinet were all we needed for the vast majority of problems. We had to resort to medical evacuation only rarely.

I found that deliberately maintaining a high degree of visibility among the troops was rewarded by good communication and a stronger sense of comradeship, which undoubtedly improved my ability to treat the people about me.

In this paper I also tried to mention a number of other significant medical/public health problems often found in the Pacific islands which, by and large, were not present on the Eniwetak Atoll but might be found in similar

operations in that part of the world. Some diseases, parasites, and environmental problems are discussed.

Finally, I have included a brief review of considerations and options necessary for the planning of military operations in remote Pacific island settings: the number of people to be cared for; the expected duration of the project; the locale; the nature of the project itself; and the possibility of attack. The Air Force and Army have several sizes of mobile medical facilities that can be quickly dispatched and set up rapidly. Basically, each situation must be individually planned by people with a full knowledge of resources available and- hopefully- some field experience.

APPENDIX



FCRA

DEFENSE NUCLEAR AGENCY
FIELD COMMAND
JOINT TASK GROUP - ENEWETAK ATOLL
APO, SAN FRANCISCO 96333

36

EAI NO.
5602
15 July 1977

ENEWETAK ATOLL INSTRUCTION NO. 5602

SUBJECT: Heat Injuries

Enclosure: None

1. Purpose: To prescribe policies and procedures to prevent heat injuries.

2. Cancellations: None

3. Applicability: This instruction is applicable to all personnel on Enewetak Atoll.

4. Policy: Commanders and supervisors may expect heat injuries whenever men are exposed to elevated temperatures. During the months of increased heat stress, lack of adequate amounts of water and salt will increase the danger of heat injury, as will improper acclimatization.

5. Responsibilities:

a. Commanders/Supervisors:

(1) Insure that an adequate water supply is available at all times and that personnel drink frequently and in sufficient quantities, particularly during high heat stress conditions.

(2) During the acclimatization period, assess the cumulative effect of fatigue resulting from the day's activities and schedule work accordingly.

(3) Insure that an adequate amount of salt is ingested during each meal to replace the loss of body salts.

(4) Be able to identify environment conditions under which adverse effects of heat are likely to occur, recognize the earliest signs of heat injuries, and take appropriate action to prevent reoccurrence.

b. Medical Personnel:

(1) Assist commanders by providing technical assistance and continu-

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ously educating personnel in the prevention of heat injuries.

(2) Continuously monitor and advise the commander on conditions which have adverse effects on personnel.

c. Individuals: Insure that they drink sufficient amounts of water and replace salt loss, by consuming an adequate amount of salt at each meal.

6. Procedures:

a. Acclimatization: This is essential in reducing heat injuries and is a gradual process which conditions the body to perform effectively in the heat. Acclimatization begins with the first exposure and is fairly well developed by the end of one week. Individuals unusually susceptible to heat will require additional time for acclimatization. A period of two weeks should be allowed for complete acclimatization. Supervisors and responsible officers will provide an acclimatization period for all personnel. If it is necessary that work be accomplished during the period of acclimatization, advantage should be taken of the cooler hours in accomplishing the work. A schedule should be established which provides for increasingly longer work periods alternating with rest periods. The first day's schedule should not exceed a total of two (2) hours of work if heat injuries are to be avoided. Under moderately hot conditions (less than 85 degrees WBGT), five (5) minute rest periods in the shade alternating with 25 minutes of work in the sun may be desirable if it is necessary to work in the sun. Increased temperature will result in increasing the rest periods.

b. Education:

(1) Prevention of heat casualties depends largely on the education of personnel exposed and especially upon supervision by responsible commanders. Prior to the onset of hot weather, every individual to be exposed to high temperatures will be informed of the potentially serious results of heat injury, the general nature of these conditions, and how they can be prevented. All personnel should be able to apply effective first aid and obtain medical assistance promptly.

(2) Areas of educational emphasis should include the following:

(a) Mental confusion and overactivity commonly precedes collapse from heatstroke.

(b) The risk of heat injury is much higher in overweight persons and special care should be exercised when such persons are exposed to high

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temperatures.

(c) One attack of either heatstroke or severe heat exhaustion may predispose to a second. Predisposition is not developed in the case of heat cramps.

(d) Avoid dehydration, fatigue, lack of sleep, and the use of alcohol.

(e) Under conditions of heat stress, meals should be cool rather than hot. The heaviest meal should be served in the evening rather than at noon. An hour of rest following the noon meal is beneficial.

(f) Knowledge of various heat alert categories.

c. Human Body Requirements.

(1) Water: The human body is highly dependent upon water to cool itself in a hot environment. Man cannot be conditioned to adjust to decreased water intake. An individual subjected to high heat stress may, by sweating, lose water in excess of one quart per hour. Individuals should drink water frequently and in sufficient quantities. Thirst is not an adequate stimulus for water intake; therefore, command supervision is necessary to insure ample water intake. An adequate water supply will be available to all personnel at all times, particularly during high heat stress conditions. Optimum drinking water temperature is 50 to 60 degrees fahrenheit.

(2) Salt: In addition to water, sodium chloride (table salt) is also lost in sweating. Increased sweating normally indicates a need for additional salt consumption. The method of choice for salt replacement is through the use of additional table salt at mealtime. Palatable salted drinking water can be provided in the dining facility by dissolving 1/2 tablespoon of table salt in one gallon of cold water, and in the field by adding 1/2 canteen cup of saturated salt solution to a quart of canteen water. Intake of salt in the form of salt tablets is not normally indicated in garrison-type activities, and their use may delay acclimatization. Routine dispensing of salt tablets will not be done without the approval of the Surgeon, Joint Task Group. When needed, the slow dissolving enteric coated salt tablets are superior to plain tablets which may cause cramps, vomiting, diarrhea, or disturbance of the normal sodium/potassium balance. Requirement for additional salt intake is found to be more predominant among non-acclimatized or partly acclimatized personnel.

d. Recognition of Heat Injuries: Three fairly distinct clinical syndromes may occur, depending upon the manner of breakdown of the individual's adjustment. These syndromes are heat cramps, heat exhaustion, and heatstroke. These conditions produce distinctive signs and symptoms which should be recognized at once, not only by medical officer but also by other responsible personnel.

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All military personnel involved in the supervision of personnel in hot climates must be familiar with the symptoms of heat injury and first aid treatment.

(1) Heat Cramps:

(a) Symptoms: Painful cramps of the voluntary muscles may occur following exposure to heat. Heat cramps result primarily from a combination of improper acclimatization and excessive loss of salt from the body through active sweating. The muscles of the extremities and the abdominal wall are usually involved, and the cramps may be of great severity. Body temperature is normal.

(b) First Aid Treatment:

- 1 Remove individual to cool shade.
- 2 Administer 0.1% saline solution (two ten grain salt tablets or $\frac{1}{2}$ teaspoon salt dissolved in one quart of water.). The full quart should be consumed.
- 3 Massage arms and legs to aid blood circulation.
- 4 Contact medical treatment facility.

(2) Heat Exhaustion:

(a) Symptoms: Symptoms include profuse sweating, headache, tingling sensations, weakness, and nausea. Often no one will be aware that an individual is suffering from heat exhaustion until he collapses. The victim's skin will normally be cool and moist. Body temperature will be relatively normal. The patient should regain consciousness in a few minutes.

(b) First Aid Treatment:

- 1 Remove patient to cool shade.
- 2 Elevate patient's feet
- 3 Administer 0.1% saline solution (two ten-grain salt tablets or $\frac{1}{2}$ teaspoon salt dissolved in one quart of water). The full quart should be consumed.
- 4 Evacuate patient to the nearest medical facility.

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(3) Heatstroke: HEATSTROKE IS A MEDICAL EMERGENCY with a potentially high mortality rate.

(a) Symptoms: Characterized by a severe headache, upset stomach, weakness, and extremely high body temperature. The victim's skin will be dry, hot and pink, and sweating will be absent or greatly reduced. Unconsciousness and convulsions or delirium will be evident. Patient will not regain consciousness as he would with heat exhaustion.

(2) First Aid Treatment: The most important treatment is lowering the patient's body temperature and must be initiated as soon as possible. In the field, remove the patient's clothes. If there is any source of cool water nearby, the patient should be immersed in water, otherwise water should be sprinkled over the patient and its evaporation hastened by fanning. In addition to these cooling measures, rub the patient's extremities and trunk briskly to increase the circulation to the skin. The patient should be evacuated to the nearest treatment facility immediately, and measures to cool the patient must be continued until the medical treatment facility is reached. During transportation, the passage of air currents through the open door of an ambulance, open vehicle windows, or medevac helicopter will aid cooling.

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VITA

Lloyd Earl Dodd, Jr. was born in Pasadena, California, on 27 March, 1948, the son of Marilee and Lloyd Earl Dodd. Lloyd Jr. was graduated from Basic High School, Henderson, Nevada, in June 1965. He attended the University of Southern California on full tuition scholarship and was graduated Magna Cum Laude and Phi Beta Kappa in June 1969 with a BA in Psychology and minor in Chemistry. In the summer of 1969 he did a research fellowship working with autistic children. He then attended Baylor College of Medicine from which he was graduated in June of 1973. He served a rotating internship at Kern General Hospital in Bakersfield, California July 1973 to July 1974, when he was selected "Intern of the Year".

Lloyd practiced as a solo general practitioner in Las Vegas until March 1976, when he left his busy practice for a career in the Air Force. He served at Hickman, AFB, Hawaii; commanded the medical facility at Wheeler AFB, Hawaii; was OIC of the medical facility, Lojwa; and served as flight surgeon, Chief of Aerospace Medicine, and Chief of Emergency Services at Vandenberg AFB, California, prior to coming to San Antonio in September 1981 to commence the Air Force Residency in Aerospace Medicine.

He has become board certified in Family Practice and is now board eligible in Emergency Medicine.

Lloyd was chosen "Humanitarian of the Year" for Southern California in 1981 by an area television station.

Lloyd, however considers the highlights of his life to be his marriage to Kathleen Joyce Thomas in June, 1969, and the arrival of three children: Lloyd III ('71); Genevieve ('74); and Andrea ('78).

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